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GB 2236642 A WO 95/17686 A1 WO 90/09645 A1
US 5652707 A

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(54) Abstract Title
Transferring operational data collected at remote stations to a base station

(57) Each remote operational station 401-405 associated with a vehicle of a fleet collects data such as maintenance information or data relating to the position of the vehicle determined from GPS satellite signals. A central base station 409 instructs the remote stations as to when to initiate data transfer by transmitting a GSM SMS message 421. The message specifies the time and/or dates at which data transfer is to be initiated. At the specified time, the remote station checks if the vehicle ignition is switched off and if so, initiates a data download to the base station. Data transfer takes place over a GSM data channel. Thus the base station may schedule the transfer so that all vehicles do not attempt to transfer their data simultaneously whilst the vehicles may only initiate the transfer if local conditions are satisfactory.

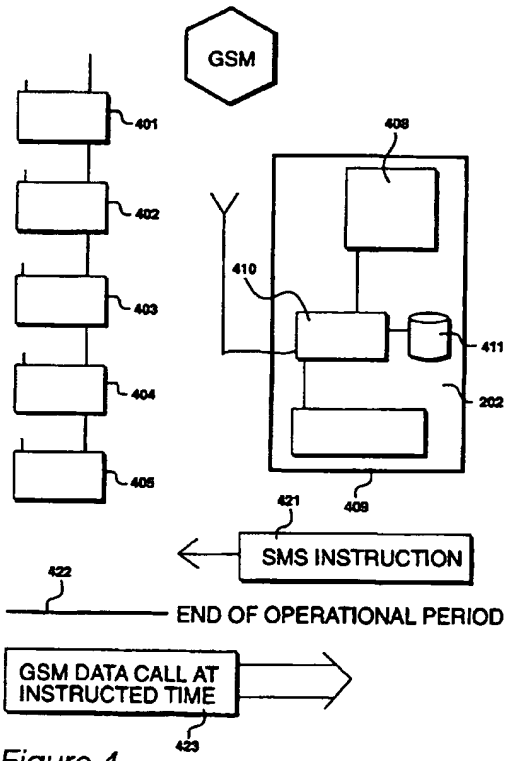

Figure 4

GB 2 345 824 A

This print incorporates corrections made under Section 117(1) of the Patents Act 1977.

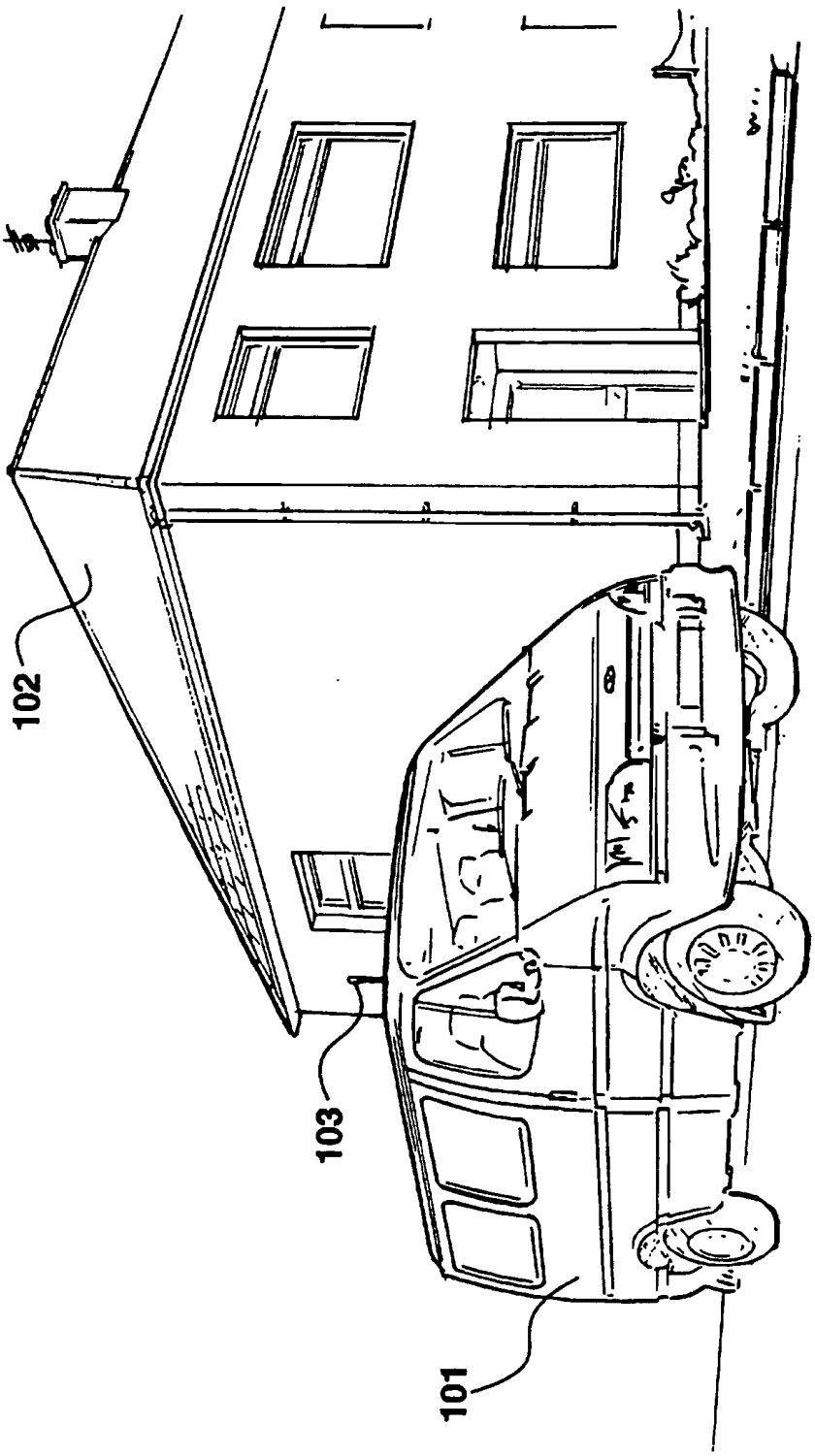

Figure 1

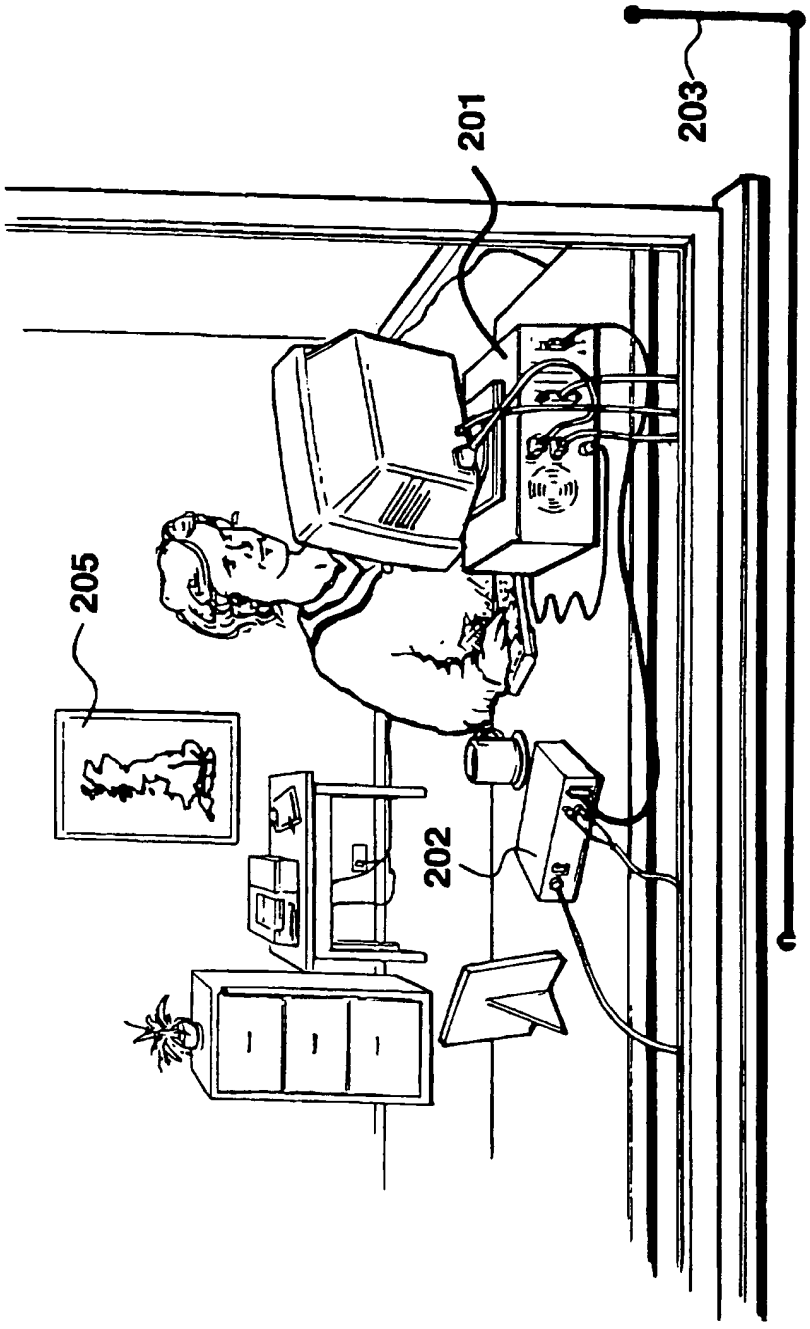

Figure 2

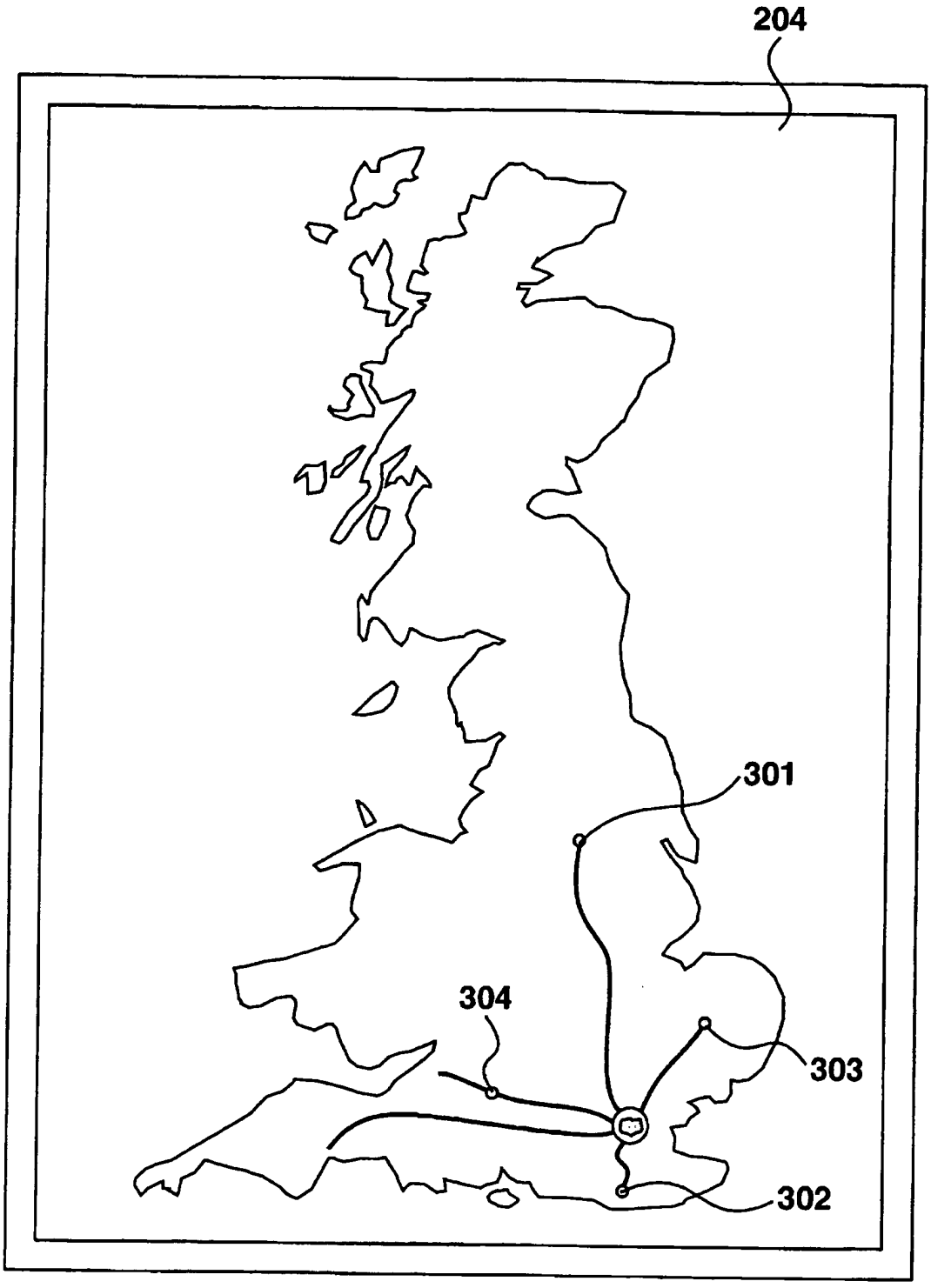

Figure 3

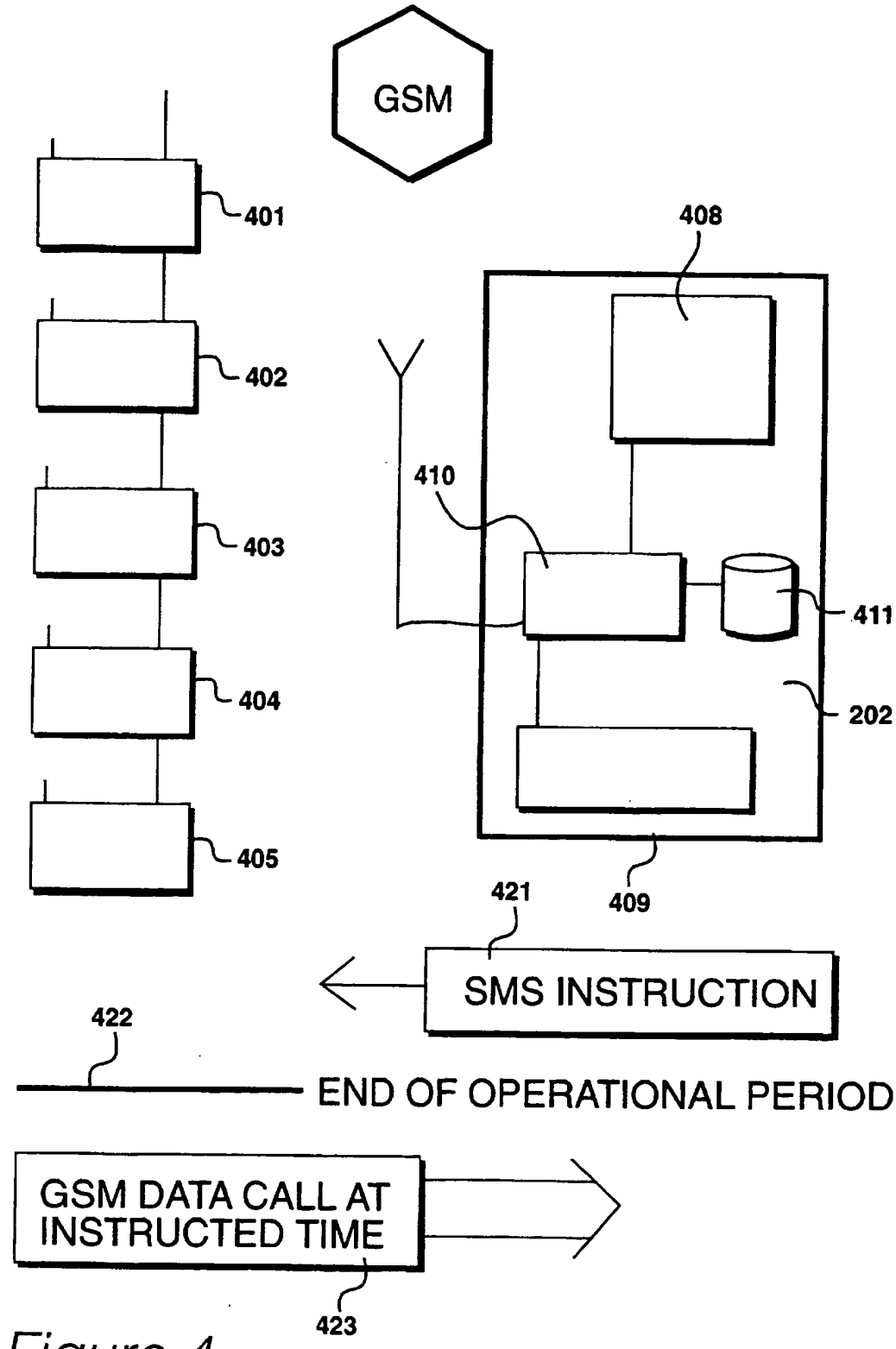
GSM
401
402
403
404
405
408
410
411
202
409
421
SMS INSTRUCTION
422
END OF OPERATIONAL PERIOD
GSM DATA CALL AT INSTRUCTED TIME
423

Figure 4

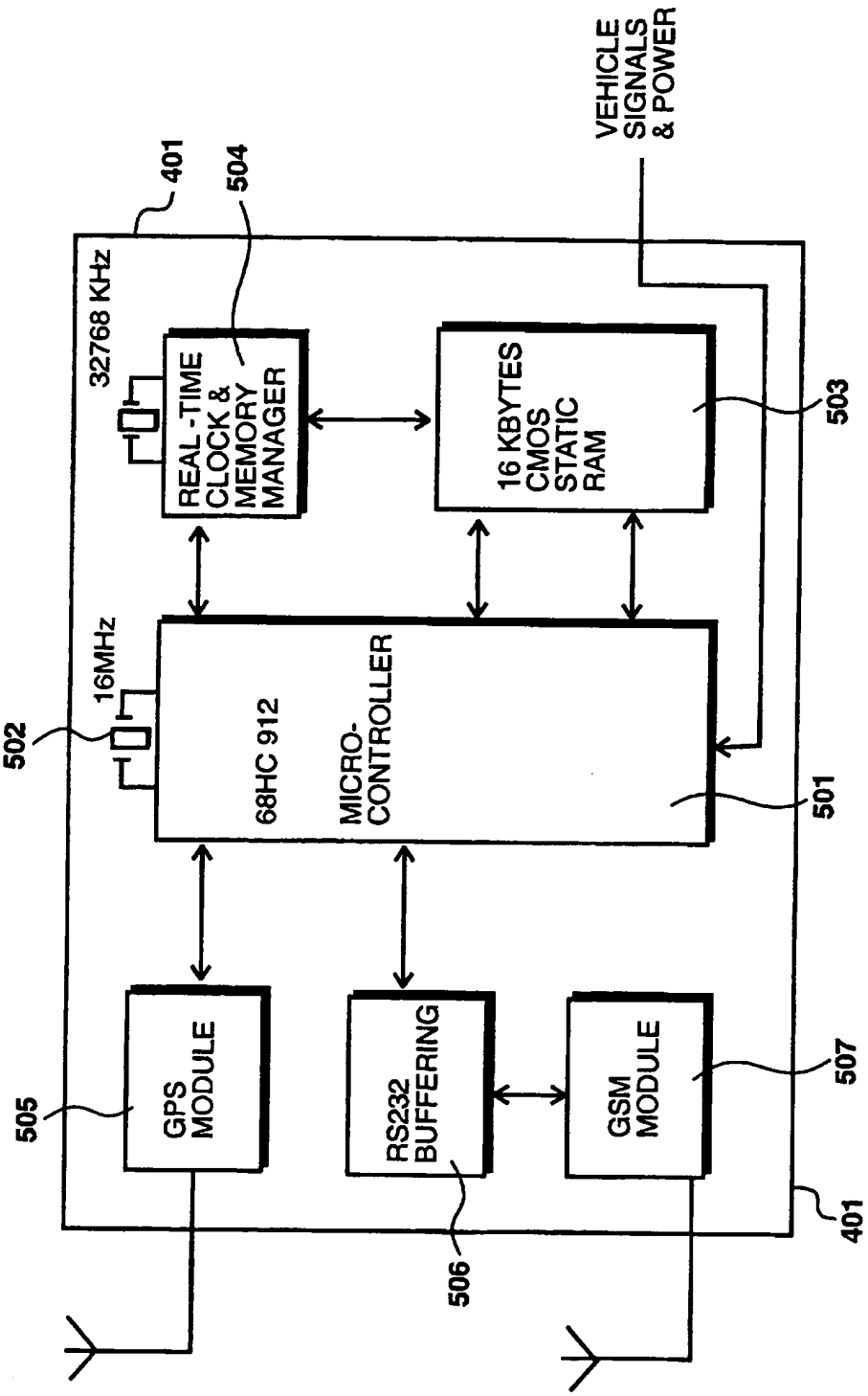
VEHICLE SIGNALS & POWER
401
504
32768 KHz
REAL-TIME CLOCK & MEMORY MANAGER
16 KBYTES CMOS STATIC RAM
503
16MHz
502
68HC 912
MICRO-CONTROLLER
501
GPS MODULE
505
RS232 BUFFERING
506
GSM MODULE
507
401

Figure 5

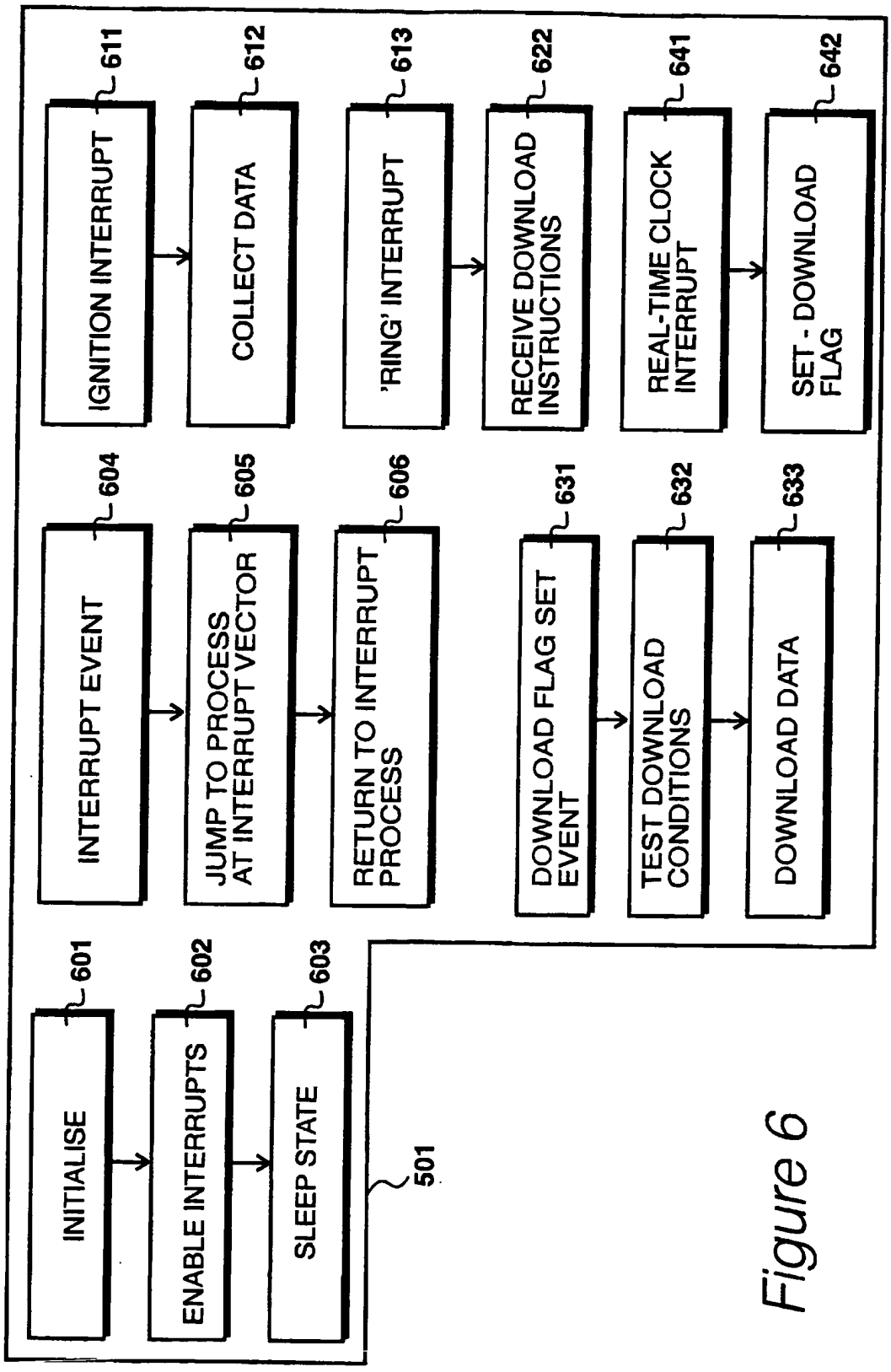
INITIALISE
601
ENABLE INTERRUPTS
602
SLEEP STATE
603
501
INTERRUPT EVENT
604
JUMP TO PROCESS AT INTERRUPT VECTOR
605
RETURN TO INTERRUPT PROCESS
606
IGNITION INTERRUPT
611
COLLECT DATA
612
'RING' INTERRUPT
613
RECEIVE DOWNLOAD INSTRUCTIONS
622
DOWNLOAD FLAG SET EVENT
631
TEST DOWNLOAD CONDITIONS
632
DOWNLOAD DATA
633
REAL-TIME CLOCK INTERRUPT
641
SET - DOWNLOAD FLAG
642

Figure 6

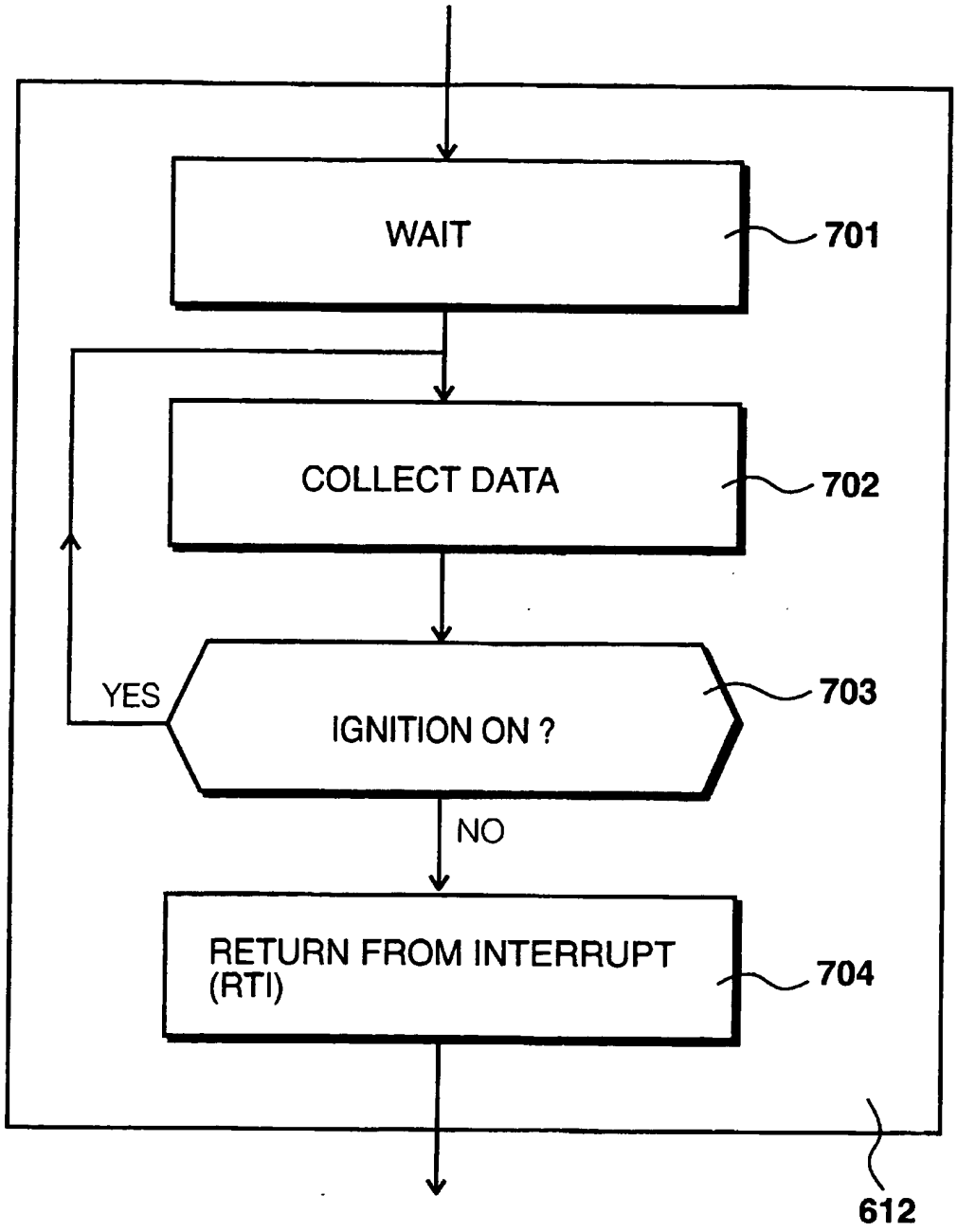
WAIT
701
COLLECT DATA
702
YES
IGNITION ON ?
703
NO
RETURN FROM INTERRUPT (RTI)
704
612

Figure 7

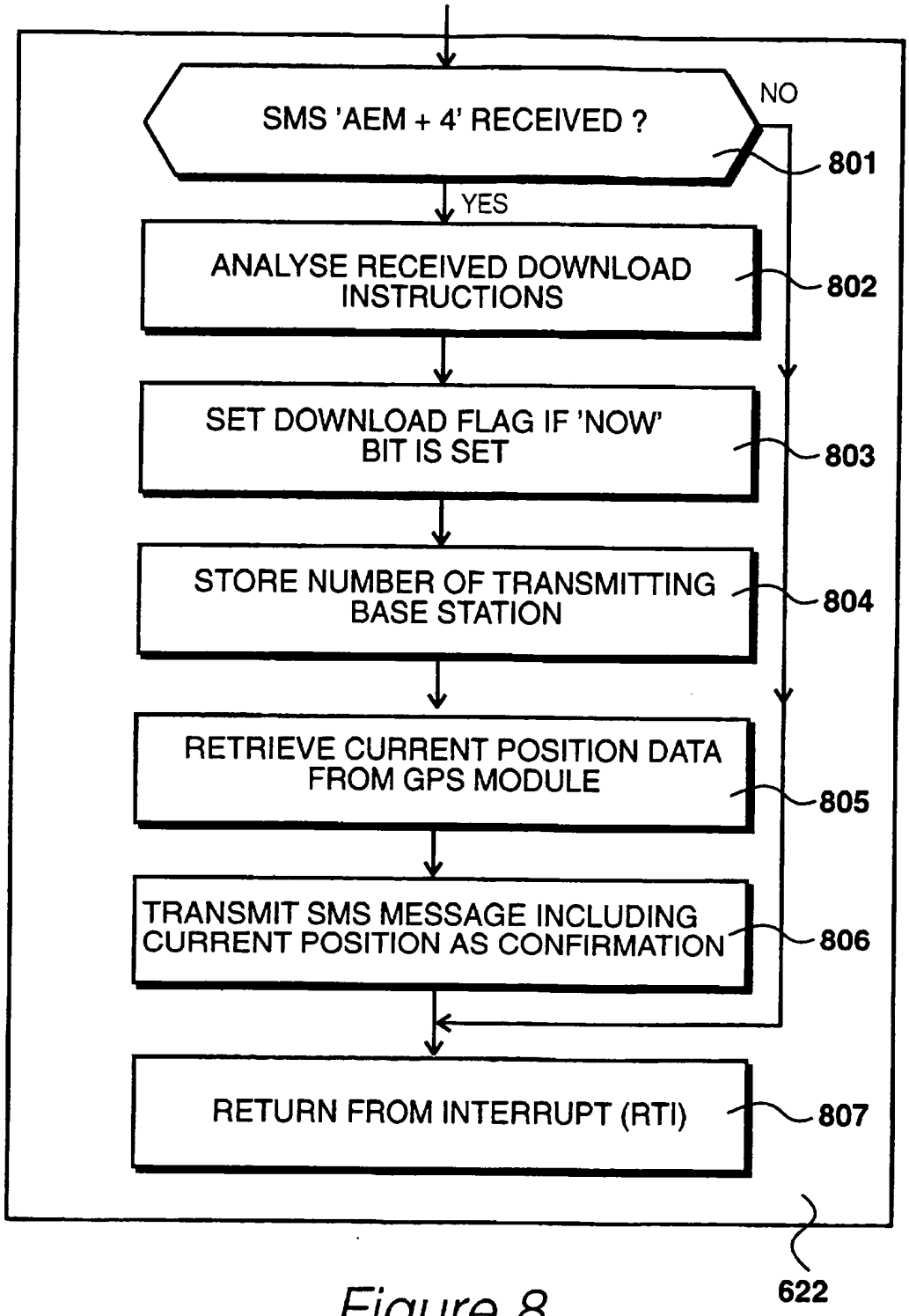
SMS 'AEM + 4' RECEIVED ?
NO
801
YES
ANALYSE RECEIVED DOWNLOAD INSTRUCTIONS
802
SET DOWNLOAD FLAG IF 'NOW' BIT IS SET
803
STORE NUMBER OF TRANSMITTING BASE STATION
804
RETRIEVE CURRENT POSITION DATA FROM GPS MODULE
805
TRANSMIT SMS MESSAGE INCLUDING CURRENT POSITION AS CONFIRMATION
806
RETURN FROM INTERRUPT (RTI)
807
622

Figure 8

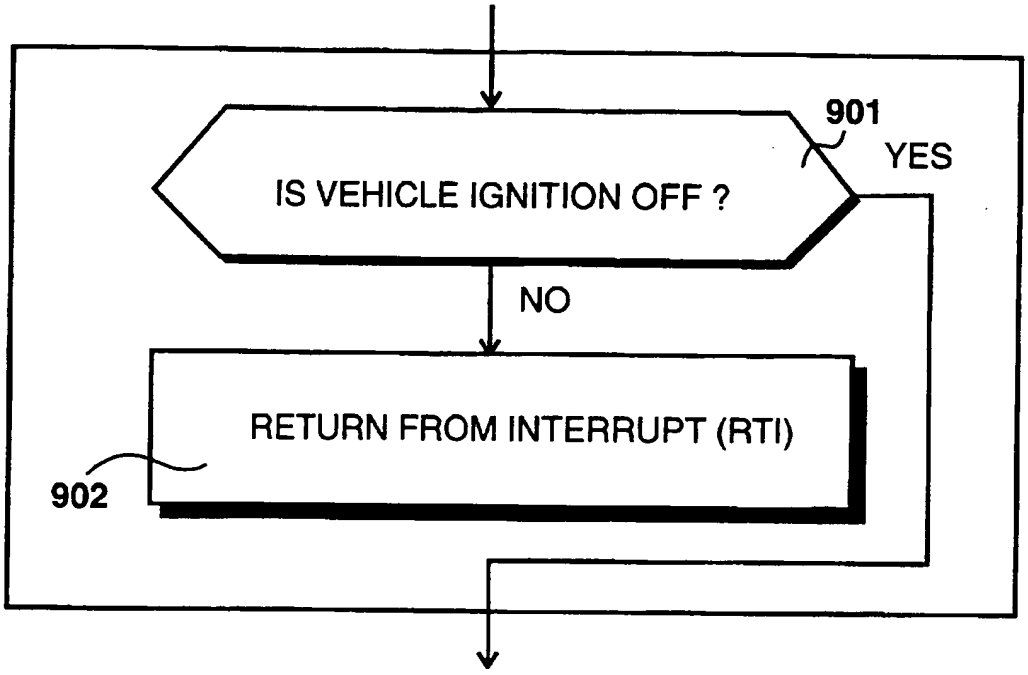
901
YES
IS VEHICLE IGNITION OFF ?
NO
RETURN FROM INTERRUPT (RTI)
902

Figure 9

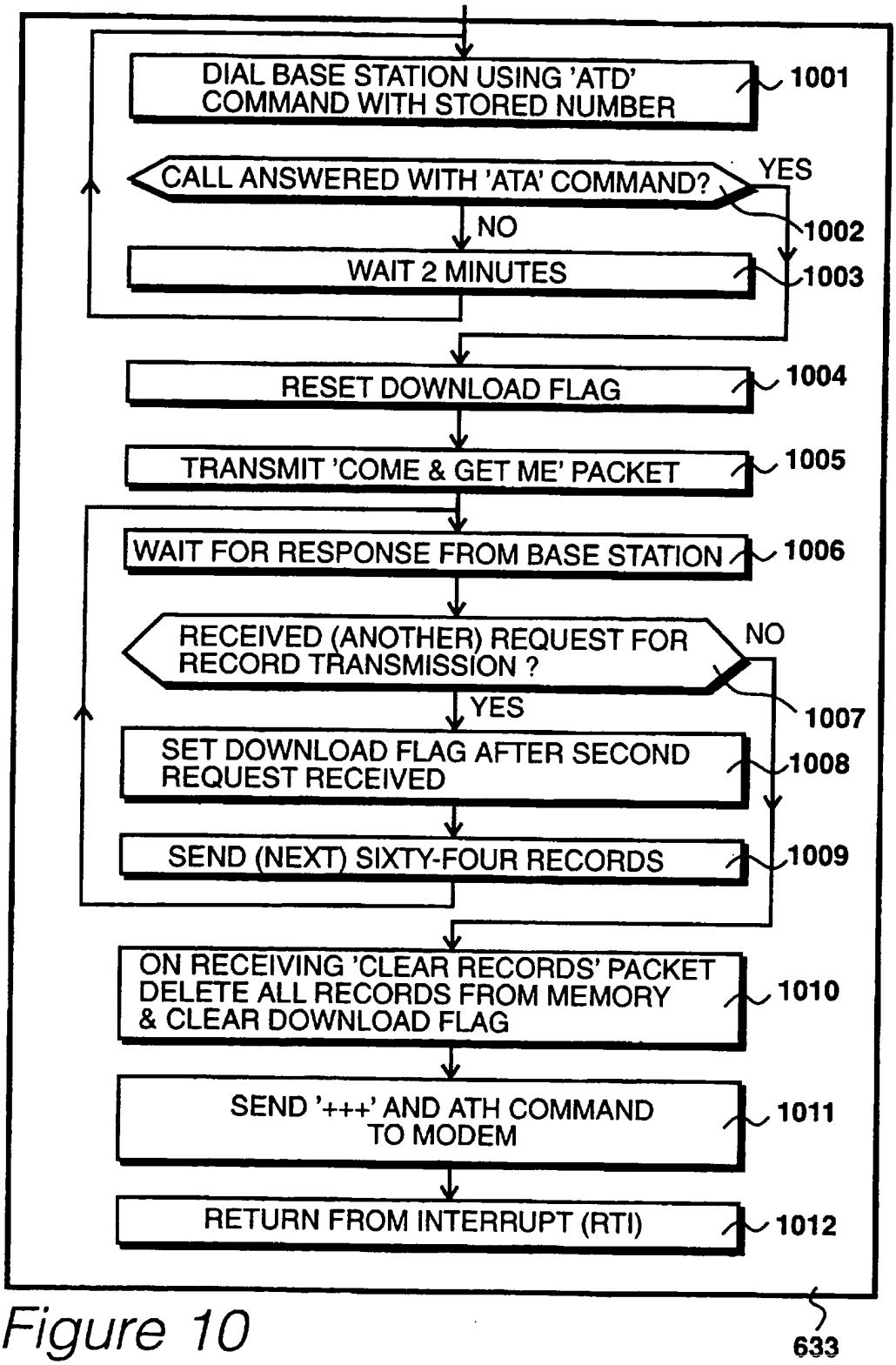
DIAL BASE STATION USING 'ATD' COMMAND WITH STORED NUMBER
1001
CALL ANSWERED WITH 'ATA' COMMAND?
YES
NO
1002
WAIT 2 MINUTES
1003
RESET DOWNLOAD FLAG
1004
TRANSMIT 'COME & GET ME' PACKET
1005
WAIT FOR RESPONSE FROM BASE STATION
1006
RECEIVED (ANOTHER) REQUEST FOR RECORD TRANSMISSION ?
NO
YES
1007
SET DOWNLOAD FLAG AFTER SECOND REQUEST RECEIVED
1008
SEND (NEXT) SIXTY-FOUR RECORDS
1009
ON RECEIVING 'CLEAR RECORDS' PACKET DELETE ALL RECORDS FROM MEMORY & CLEAR DOWNLOAD FLAG
1010
SEND '+++' AND ATH COMMAND TO MODEM
1011
RETURN FROM INTERRUPT (RTI)
1012
633

Figure 10

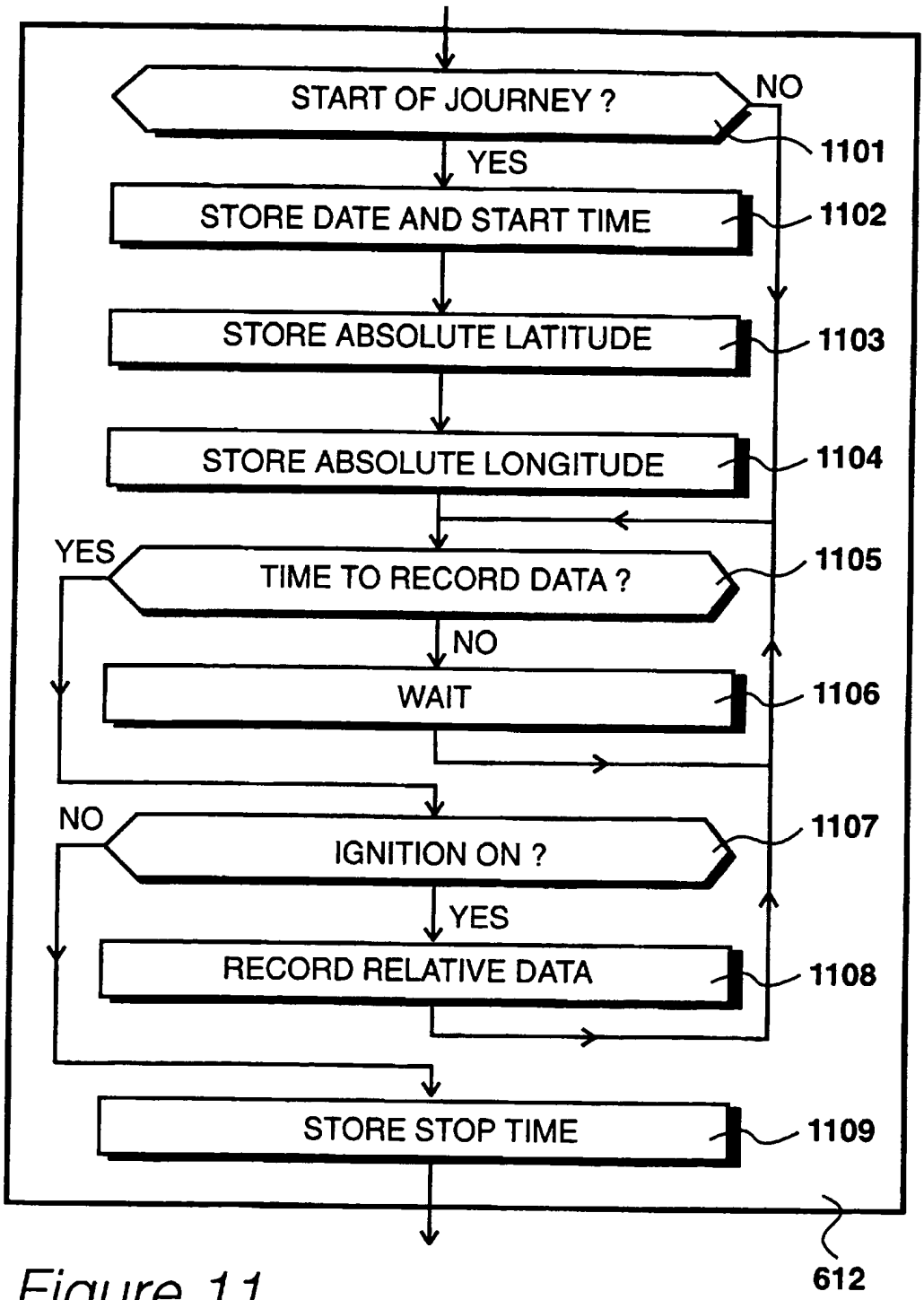
START OF JOURNEY ?
NO
1101
YES
STORE DATE AND START TIME
1102
STORE ABSOLUTE LATITUDE
1103
STORE ABSOLUTE LONGITUDE
1104
YES
TIME TO RECORD DATA ?
1105
NO
WAIT
1106
NO
IGNITION ON ?
1107
YES
RECORD RELATIVE DATA
1108
STORE STOP TIME
1109
612

Figure 11

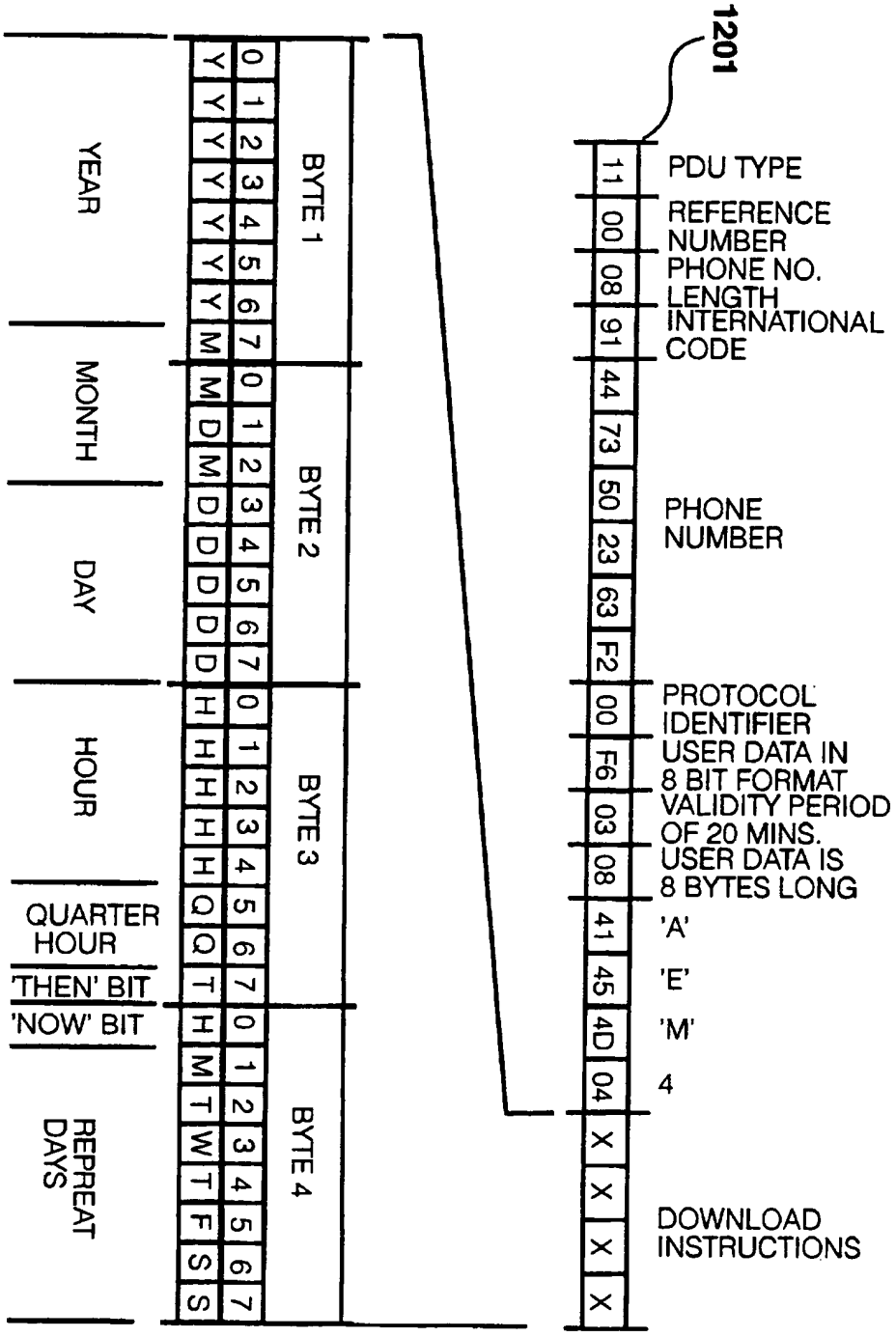
1201
YEAR
MONTH
DAY
HOUR
QUARTER HOUR
'THEN' BIT
'NOW' BIT
REPEAT DAYS
BYTE 1
BYTE 2
BYTE 3
BYTE 4
PDU TYPE
REFERENCE NUMBER
PHONE NO. LENGTH
INTERNATIONAL CODE
PHONE NUMBER
PROTOCOL IDENTIFIER
USER DATA IN 8 BIT FORMAT
VALIDITY PERIOD OF 20 MINS.
USER DATA IS 8 BYTES LONG
'A'
'E'
'M'
4
DOWNLOAD INSTRUCTIONS

Figure 12

VALUE	OFFSET FROM HOUR
00	EXACTLY ON THE HOUR
01	15 MINUTES PAST THE HOUR
10	30 MINUTES PAST THE HOUR
11	45 MINUTES PAST THE HOUR

Figure 13

VALUE	DAILY PATTERN
0000010	DOWNLOAD EVERY SATURDAY
0101000	DOWNLOAD EVERY TUESDAY & THURSDAY
1111100	DOWNLOAD MONDAY TO FRIDAY
1111111	DOWNLOAD EVERY DAY

Figure 14

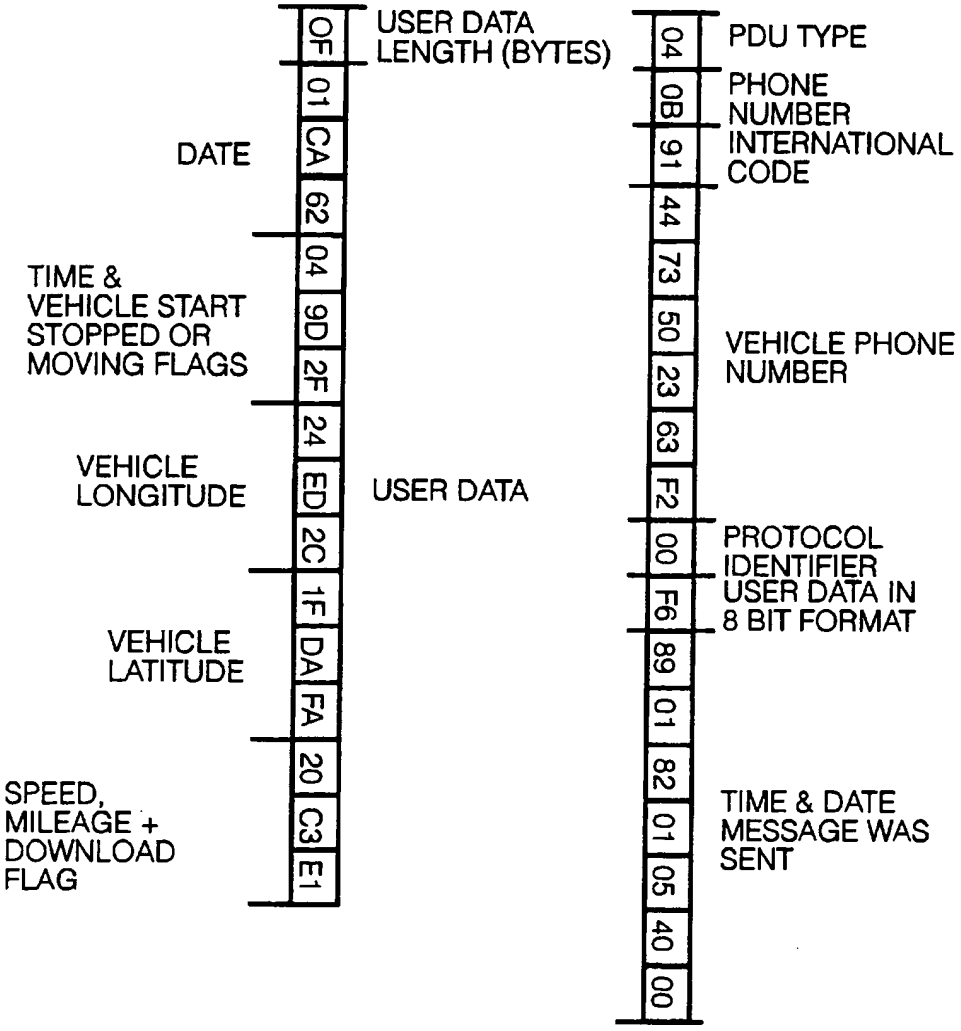
USER DATA LENGTH (BYTES)
0F
DATE
01 CA 62
TIME & VEHICLE START STOPPED OR MOVING FLAGS
04 9D 2F
VEHICLE LONGITUDE
24 ED 2C
VEHICLE LATITUDE
1F DA FA
SPEED, MILEAGE + DOWNLOAD FLAG
20 C3 E1
USER DATA
PDU TYPE
04
PHONE NUMBER INTERNATIONAL CODE
0B 91
VEHICLE PHONE NUMBER
44 73 50 23 63 F2
PROTOCOL IDENTIFIER
00
USER DATA IN 8 BIT FORMAT
F6
TIME & DATE MESSAGE WAS SENT
89 01 82 01 05 40 00

Figure 15

Transferring Operational Data

The present invention relates to transferring operational data collected at a plurality of remote operating stations, to a data receiving station.

The transfer of stored data from a vehicle to a data collection apparatus is described in the applicant's British patent 2 317 791 B. A system is described in which a first packet of data is transmitted from a vehicle to a data collection apparatus via a radio channel in response to a pre-determined event, such as the ignition of the vehicle being switched off. In response to this first packet being transmitted, the receiving station issues a second packet requesting data from the vehicle and, in response to receiving this second packet, the vehicle transmits a portion of the stored data to the collection apparatus. Thus, when a vehicle enters the vicinity of the collection station, it alerts the collection station as to when its ignition has been switched off; a condition which has been identified as a "come and get me" signal. Thereafter, a request is made by the collection apparatus for a portion of the stored data.

By downloading the collected data in portions, it is possible for a number of transfers to take place such that all vehicles entering a collection region may have their data downloaded, thereby ensuring that no one vehicle monopolises the available transmission bandwidth.

The system described in the aforesaid patent facilitates the downloading of accumulated data in a highly efficient way, provided that the vehicles intermittently return to a central station or depot. However, in some environments, vehicles remain away from base for long periods of time possibly, for example, when drivers or operatives are working from home. Furthermore, downloading techniques are also required in other environments where, for example, operational equipment remains stationary.

A system for downloading collected data from vehicles is described in United Kingdom patent application 2 288 892A. The collected data may be

supplied to a modem data-collection data dump, whereafter the data may be transmitted over a communication link to reception data dumps. In accordance with this system, the vehicle is responsible for deciding when it is appropriate for a data transmission to take place. However, a problem with this approach is that many vehicles may attempt to download data simultaneously. Consequently, significant resources are required at the collection station or, alternatively, it is possible that some vehicles would not be able to download, resulting in the possibility of accumulated data being lost.

A system is disclosed in International Patent publication WO 90/09645 in which recorded data is transmitted by radio to a base station as required. The data may be transmitted when polled by the base station and the vehicles may be polled in turn either on demand or at regular intervals. The data may be transmitted by radio to the base station while the vehicle is on the road such that the vehicle does not have to be in the vicinity of the base station.

A problem with this approach is that data may be lost or corrupted if an attempt is made to transfer data while the vehicle is moving. For example, even when radio reception is relatively good, the vehicle may enter a tunnel or the vehicle may be obscured by some other entity which temporarily prevents optimal data transmission. The initiative has been taken away from the vehicle in terms of deciding when it is appropriate for a data transmission to take place. Consequently, it is not possible for all of the vehicles to attempt to make a data transfer at the same time, thereby the provision of equipment at the central station may be significantly reduced. Under these operating conditions, it is the responsibility of the central station to poll the individual vehicles so that they may then in turn perform the data download. However, a problem with this approach is that the vehicles may be polled at times when it is inappropriate for the data transfer to take place, resulting in potential data loss or data corruption.

To summarise, if the initiative is taken by the vehicles in terms of deciding when to transfer data, it is possible that insufficient resources may be available at the receiving station, possibly resulting in data loss. Similarly, if the initiative is taken by the central station, in terms of polling vehicles to download data in response to a polling signal, it is possible that the polled vehicle may be in a less than ideal situation for performing the data download, again running the risk of incurring data loss.

According to a first aspect of the present invention, there is provided a method of transferring operational data collected at a plurality of remote operating stations to a data base station, wherein each operational station collects data over an operational period; said base station is configured to instruct said remote stations as to when to initiate a data transfer in response to a predefined schedule; and each operational station is configured to process instructions received from said base station, to identify a time for initiating a data transfer, and to initiate a data transfer of collected data to said base station at the instructed time.

The present invention results in the times for data transfer being controlled by the central station. However, the central station does not poll the vehicles, as shown in the previously acknowledge prior art. In preference to doing this, the receiving station instructs the remote stations as to when a data transfer may be initiated in the future. The remote stations process this instruction in order to identify a time for initiating a data transfer. In this way, the central station ensures that the vehicles transmit their collected data at different times, thereby enabling the central station to communicate with its preferred number of vehicles at any one time. Thus, the vehicles are not polled but are instructed to initiate the transfer of data in accordance with the instruction.

In a preferred embodiment, said operational stations are attached to motor vehicles and data collected over said operational period relates to the operation of the vehicle to which the operational station is attached.

Preferably, the collected data relates to geographical positions of the vehicle to which the operational station is attached. Alternatively, or in addition thereto, the operational data relates to operational conditions of the said vehicle.

Preferably, an instruction signal identifies a specific time for a data transfer to be initiated. In addition, the instruction may instruct a remote operational station to transfer data at a particular time, at a particular day of the week and to continue transmitting at the appointed time and day until further instructions are received.

In a preferred embodiment, a checking operation is performed at the instructed time for initiating a data transfer so as to check that appropriate conditions exist for the transfer to take place. Preferably, at each vehicle, a check is made to determine whether the ignition has been switched off and a data transfer is only performed when the ignition is off. In this way, it is not possible for a data transfer to take place if the vehicle is moving.

In a preferred embodiment and as described in the present applicant's British Patent No 2 318 940 B, relative positional data is transmitted in combination with absolute positional data, so as to reduce the totality of the data that is required to be stored and transmitted. However, a problem associated with the transmission of data in this form is that the data itself is more susceptible to corruption or data loss, particularly if absolute positional data is lost. The present invention facilitates the transmission of data in this compressed form, given that data transfers may be scheduled to take place sequentially and at optimum times.

According to a second aspect of the present invention, there is provided apparatus for transmitting operational data collected at a plurality of remote operating stations to a data receiving base station, comprising means for collecting data at each operational station over an operational station; means at said base station configured to instruct said remote stations as to when to initiate a data transfer in response to a predefined schedule; and

means at said operational stations configured to process instructions received from said base station, to identify a time for initiating a data transfer, and to initiate a transfer of collected data to said base station at said instructed time.

In a preferred embodiment, the base station includes means for contacting remote stations by means of GSM SMS messages and the remote stations may include means for downloading data over a GSM data channel.

According to a third aspect of the present invention, there is provided apparatus attachable to a motor vehicle and to configure to collect operational data relating to operational characteristics of said vehicle, comprising means for receiving instructional data from a base station identifying a time at which a data transfer is to be initiated; and a means for initiating a transfer of collected data to an instructing base station at said instructed time.

Preferably, the apparatus is configured to collect operational data relating to positions of a vehicle over an operational period and said apparatus may include means for receiving GPS satellite signals and means for processing signals received from said satellite in order to determine said vehicle positions.

Preferably, the apparatus includes means for receiving download instruction via a GSM SMS channel and means for downloading accumulated data back to a base station over a GSM data channel.

In a preferred embodiment, the apparatus includes means for checking that the ignition of the vehicle is switched off at the time instructed to initiate a data download and means for preventing said download occurring if the vehicle ignition is switched on.

The invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a vehicle parked outside a driver's house;

Figure 2 shows a receiving station for receiving information transmitted from vehicles of the type shown in *Figure 1*;

Figure 3 illustrates a map showing the location of fleet depots;

Figure 4 illustrates the general operation of the data accumulation and transmission systems;

Figure 5 details a data accumulation device of the type identified in *Figure 4*;

Figure 6 details a micro controller of the type identified in *Figure 5*;

Figure 7 details a process for the collection of data, identified in *Figure 6*;

Figure 8 details a process for receiving download instructions, identified in *Figure 6*;

Figure 9 details a process for testing download conditions;

Figure 10 details a process for the downloading of positional data, identified in *Figure 6*;

Figure 11 details a data collection process;

Figure 12 details the structure of an instruction packet;

Figure 13 illustrates the coding for quarter hour periods;

Figure 14 illustrates the coding of daily pattern data; and

Figure 15 details an acknowledgement packet.

A vehicle **101** is shown in *Figure 1*, parked outside a driver's house **102**. The driver operates from home and the vehicle rarely enters a depot or similar environment where it would be possible to perform a data download operation using a locally based dedicated radio system. Information relating to the journeys made by the vehicle are required by a central station and provision is made for this data to be collected using positional detection apparatus.

In addition to positional data, it is possible for other operational data to be transmitted from the vehicle to the central station, such as operating characteristics of the vehicle which may in turn be used by the central station

in order to anticipate mechanical problems with the vehicle so that servicing and repairs may be scheduled in advance of a problem occurring. Consequently, the vehicle transmits collected data via a mobile telephone data network, such as a GSM network, by means of an aerial **103**.

In this embodiment, the collecting station is shown as a vehicle and the vehicle is primarily collecting data relating to its journeys. However, the system is also applicable to other operational devices, which could be permanently positioned at a specific location, where data is collected relating to the operation of the device and then subsequently transmitted to a collection station. Thus, such devices would collect data over an operational period and then transfer the data at a time instructed by the central station, provided that local conditions permit. These local conditions may, for example, state that the device in all other respects must be non operational such that if the device were operating, it would not be possible for the transfer of data to take place.

An operational station, such as vehicle **101** in the preferred embodiment, collects data over an operational period and a data receiving base station is configured to instruct the vehicle as to when to initiate a data transfer in response to a pre-defined schedule. Thus, at a base station, a schedule is specified as to when it is appropriate for each vehicle in the field to perform its data transfer. A specific instruction may be to the effect that a vehicle should initiate its transfer of data at 1.00 am in the morning on a particular day. Alternatively, more general instructions may be issued to the effect that the transfer should be made at a particular time on a particular day of the week, each week. Thus, for example, a vehicle could be instructed to download collected data on each Friday of the week at, say, 1.30 in the morning.

The vehicle is configured to process instructions received from the receiving station so as to identify a time for initiating a data transfer. Data transfer involves the establishment of a data transmission channel and this

establishment is performed by the vehicle itself. Thus, instructions received from the collection station merely provide instructions as to when it would be appropriate for the data to be transferred and this communication does not in itself initiate or create a channel for the transfer of collected data. In the preferred embodiment, instructions specifying times when data transfers should take place are made using the small message service (SMS) of a GSM mobile telephone network. Thereafter, at the appropriate time, the actual transfer of collected data is made via a GSM data channel, having significantly greater bandwidth than an SMS channel.

When the appropriate time for initiating a data transfer is reached, the vehicle checks that it is appropriate for the data transfer to take place and the data transfer is only initiated if the local checking step is satisfied. In the embodiment, a transfer of data from vehicle 101 is only permitted if the vehicle is stationary. This condition is checked by checking the condition of the vehicle and the data transfer is only possible if the ignition to the vehicle has been switched off. Thus, although the data transfer may be scheduled for a time during which it would be expected that the vehicle should be non-operational, a further check is made to ensure that the vehicle is actually non-operational and the transfer of data is only possible if this non-operational condition is satisfied. Thus, for example, if a driver needs to make an emergency trip during the middle of the night, and a transfer of data has been scheduled during this period, the actual transfer of data will not take place given that the checking operation will not be satisfied. This is to ensure that the transmission of data is not interrupted and that a good communication channel is established while the communication takes place.

Vehicle **101** is configured to receive transmissions from GPS satellites in order to provide positional information. This information is recorded at specified intervals of journeys made by the vehicle and this positional data is then collected locally by the vehicle for subsequent transmission to the receiving station. Details of the GPS system are disclosed in the applicant's

British patent 2 317 791 B. Transmissions made by the vehicle, in accordance with its instructions, are received by a receiving station of the type shown in *Figure 2*. The receiving station also communicates by means of a GSM telephone connection. In this way, it is possible for the receiving stations to exploit the SMS messaging system for both the transmission and reception of relatively small quantities of data. The data is collected by means of a general purpose data processing system **201**, preferably operating under a multi-tasking environment such as windows NT. GSM telephony communications are performed via a GSM modem **202** and an appropriate aerial **203**.

The accumulation of data by data processing system **201** is performed as a background process, thereby allowing the system to be used for general purpose office activities. In this way, the information is readily available to a fleet manager as and when required. The information retained on system **201** may be made available to similar systems throughout an office by means of a local area network. A fleet manager may print results and maps etc via an appropriately interfaced printer **204** and a map **205** of the geographic area of interest may be made available for conventional marking etc.

Map **205** is detailed in *Figure 3*. In this example, the fleet operator has a main depot in Leeds **301**, with subsidiary depots in Brighton **302**, Cambridge **303** and Swindon **304**. Some vehicles visit these depots regularly, thereby allowing data to be downloaded in a manner substantially as described in the present applicant's British patent specification 2 317 791 B. However, the vehicle shown in *Figure 1* rarely if ever visits any of these depots, therefore provision is made for the data collected by vehicle **101** to be downloaded to station **201** by means of a public GSM telephone network.

General operation of the data accumulation and transmission system is illustrated in *Figure 4*. In this example, five data accumulation devices **401**, **402**, **403**, **404** and **405** accumulate data for transmission to data processing system **202**. As shown in *Figure 4*, data processing system **202** has an

output display device **408**, an input device **409**, a central processing unit **410** and a permanent storage device **411**.

Operational data is collected by each of the remote operating stations **401** to **405**. After their operational period, the remote stations may download data to the receiving station. The receiving station instructs each remote station as to when to initiate a data transfer in response to a pre-defined schedule, by means of an SMS instruction **421**. This SMS instruction would usually be transmitted during the operational period such that it may then be acted upon after the operational period. The end of the operational period is illustrated schematically by line **422**. At the time specified by SMS instruction **421**, a GSM data call **423** is made at the instructed time. In this way, it is possible for the remote stations to have some control as to when the downloading of data is performed. They initiate this downloading process and if appropriate conditions for downloading do not exist, they have the option of delaying the downloading of data until the next scheduled download period. However, in order to ensure that the receiving station does not become overloaded, it schedules the downloading periods and transmits the scheduled data by means of an SMS instruction **421**.

Data accumulation device **401** is detailed in *Figure 5*. The device includes a Motorola 68HC912 Micro-controller **501** running at sixteen megahertz in response to a quartz crystal oscillator **502**. Micro-controller **501** includes program read-only memory for executable instructions and also communicates with a random access memory device **503** providing sixteen kilobytes of CMOS static memory. A real-time clock and memory manager circuit **504** ensures that data held within memory **503** is maintained when the remaining circuitry is switched off. In addition, circuit **504**, clocked at 32768 kilohertz, also provides real-time clock information to the micro-controller **501**. In this way, it is possible for the micro-controller to maintain real-time time and date information, thereby allowing the micro-controller to interpret date and time related information and instructions, and for real-time dependent

interrupt signals to be generated.

A serial interface of the micro-controller **501** communicates with a GPS module **505**. The micro-controller **501** issues a request to module **505**, and in response to this request, positional data is returned from the GPS module to the micro-controller. An RS232 buffering circuit **506** provides a bi-directional communication channel between the micro-controller **501** and a GSM module **507**. The micro-controller **501** is only provided with one serial port, used for communicating with the GPS module, therefore an additional serial port is configured in software using standard I/O connections of the micro-controller. The GSM module **507** allows SMS instructions to be issued and provides for GSM data to be transmitted and received. The GSM module **507** may be a Motorola D10, providing a combined GSM phone and data module in a small fully shielded stainless steel case.

Micro-controller **501** is shown generally in *Figure 6*, with an indication of the interrupt driven procedures executable by the micro-controller. On initialisation, as illustrated at step **601**, interrupts are enabled at step **602**, whereafter the processor enters a sleep state at step **603**. In this way, the processor **501** consumes minimal power when not being required to actually process events.

The processor's response to an interrupt event is illustrated at step **604**. In response to an interrupt event occurring, the program counter jumps to an appropriate process identified by an interrupt vector at step **605**. The process initiated at the memory location identified by this vector is performed, whereafter control returns to the interrupted process, possibly sleep state **603**, at step **606**.

Four interrupt events are illustrated in *Figure 6*. The processor receives an interrupt, as shown at step **611**, in response to the vehicle ignition being switched on. After entering this condition, positional data and other related data are collected at step **612**.

A ring interrupt is illustrated at step **621**. In response to receiving such

an interrupt, instructions from the central station, shown in *Figure 2*, are received by means of an SMS communication. Again, after performing this operation, control is returned to the interrupted process.

The downloading of data, over a GSM data channel, is performed when a download flag has been set. A download flag event is identified at step **631**, whereafter, at step **632**, the download conditions are tested and, if the download conditions permit, the downloading of data is performed at step **633**. Again, after all of the data has been downloaded, control returns to the interrupted process.

The download flag may be set in response to an immediate instruction to download data. Alternatively, and in accordance with the present invention, the download flag is set in response to a real-time clock interrupt, as illustrated at step **641**. Thus, in response to instructions received from the base station, a time is identified at which a download is to be performed. This alarm time is retained by the real-time clock **504**, thereby allowing the micro-controller **501** to enter its wait state and an alarm interrupt is generated at the appropriate alarm time. Thus, real-time clock **504** generates a real-time interrupt shown at step **641** which in turn results in the download flag being set at step **642**. In response to this, a further interrupt is generated at step **631** as previously described.

The ring interrupt initiated at step **621** and the download interrupt initiated at step **631** should not themselves be interrupted by other interrupt processes. Consequently, these interrupt processes are given higher priority than the other interrupt processes that are not so time critical.

Process **612** for the collection of data is detailed in *Figure 7*. After detecting the ignition on condition at step **611**, process **612** effectively enters a ten second wait state at step **701**. Thereafter, data is collected, by means of enquiries to the GPS module **505**, at step **702**. At step **703** a question is asked as to whether the ignition is still on and, if answered in the affirmative, control is returned to step **702**. Eventually, the ignition will be switched off,

resulting in the question asked at step **703** being answered in the negative, whereafter a return from interrupt instruction is generated at step **704**.

Process **622** for receiving download instructions is detailed in *Figure 8*. An instruction is transmitted from the base station to a remote station by means of an SMS message, a facility available when communication is established between two GSM telephones or GSM modems. The base station initiates a communication to a particular remote station, with appropriate telephone protocols being overseen by the GSM module **507**. This then results in a packet of information being supplied to the micro-controller **501** via the buffering circuit **506**.

Process **622** is interested in receiving packets of a particular type via the SMS protocol which, for the purposes of this embodiment, have been identified as "AEM+4" packet types. Consequently, a question is asked at step **801** as to whether an AEM+4 packet type has been received and when this question is answered in the negative, control is directed to step **807** to generate a return from interrupt command.

If the question asked at step **801** is answered in the affirmative, the download instructions are analysed at step **802** and, as a result of this analysis, data registers, memory locations and real-time clock **504** are updated where appropriate.

If, in response to the analysis performed at step **802**, it is determined that the "NOW" bit of the message has been set, the download flag is set at **803**, subsequently resulting in a download flag event interrupt being generated at step **631**. At step **804**, the number of the transmitting base station is stored, to facilitate subsequent data communications at the instructed time.

At step **805** current position data is retrieved from GPS module **505** whereafter at step **806** an SMS message, including the current position, is transmitted back to the base station as confirmation to the effect that the original instruction had been received. Thereafter, control is directed to step

807.

Step **662** for the testing of download conditions is detailed in *Figure 9*. In this example, the remote stations are prevented from performing a data download if the ignition to the vehicle is switched on, suggesting that the vehicle is moving or is about to move. In such circumstances, there is a risk that data transmission could be lost, resulting in the loss of positional data. However, in alternative embodiments, other tests could be performed appropriate to the local conditions. Thus, the system could be deployed in vending machines and a test could be performed to determine whether the vending machine is non-operational. Thus, under such circumstances, data, relating to the day's takings of the vending machine for example, may only be transmitted back to a base station when the vending machine is not actually in the process of performing a vending operation. The importance of this process is to ensure that the data is reliably transmitted with minimal risk of data loss. Furthermore, this also ensures that the data download operation does not interfere with the normal data collection operation of the environment itself.

At step **901** a question is asked as to whether the vehicle ignition is switched off and if answered in the affirmative, control is then directed to step **633**. If, however, the question asked at step **911** is answered in the negative, a return from interrupt instruction is generated at step **902**. Thus, the interrupt procedures initiated at step **631** are terminated and control is returned back to the interrupted process.

In addition to ensuring that environmental conditions do not cause positional data to be lost during the download, the procedure of performing the download when the system is non-operational also ensure that the downloading transmission, over the GSM data channel, does not result in the corruption of positional data received from the GSM satellite. Thus, referring to *Figure 5*, non-operational periods exist during which the GSM module is active, possibly resulting in positional data being downloaded over a GSM

data channel. Similarly, operational periods exist during which the GPS module is on-line, during which satellite signals are received by its antenna. However, the downloading of data should be scheduled such that it is not possible for these modules to be simultaneously in use, thereby ensuring that there is no mutual interference.

Process **633** for the downloading of positional data is detailed in *Figure 10*. At step **1001** the base station is dialled using the ATD (AT Dial) command with the number stored as a result of an instruction being received.

At step **1102** a question is asked as to whether the call has been answered and if answered in the negative, a wait state of two minutes is entered at step **1003**, whereafter the process initiated at step **1001** is repeated.

When the call has been answered, resulting in the question asked at step **1002** being answered in the affirmative, the download flag is reset at step **1004** and a "come and get me" packet is transmitted at step **1005**. This alerts the base station to the effect that a downloading procedure is to be commenced and ensures that both the transmitting remote station and the receiving base station are prepared for this transfer of data.

At step **1006** the process enters a wait state, this line waiting for a response from the base station and at step **1007** a question is asked as to whether a request for packets has been received. If this question is answered in the negative, to the effect that a request has not been received, control is directed to step **1010**.

After receiving a request, resulting in the question asked at step **1007** being answered in the affirmative, the next sixty-four stored records are transmitted over the GSM data channel at step **1009**.

On the second iteration of this loop, from steps **1006** to **1009**, the download flag is set at step **1008** such that, should the communication fail for whatever reason, the process is made aware that a download was in process and efforts will be made to re-establish the connection.

The data transmitted to the base station includes an indication as to how much data is present therefore when all of the data has been received by the base station it will cease to issue requests for more data. Consequently, the question asked at step **1007** will be answered in the negative and control will be directed to step **1010**.

At step **1010** a "clear records" packet is detected resulting in all records within the memory being cleared and the download flag being reset. Thereafter, at step **1012** the communication is terminated by the generation of a data string representing "+++" followed by the ATH (AT Hang) command. The +++ string is identified by the GSM modem as an instruction to cease transmitting data on the basis that the next instruction will be a local off-line instruction for it, rather than a data string to be transmitted. Thereafter, the procedure returns from interrupt at step **1012**.

Process **612** for the collection of data is detailed in *Figure 11*. At step **1101** a question is asked as to whether this is the start of the journey, which would be answered in the affirmative on the first iteration. Consequently, the date and the start time are stored at step **1102**. At step **1103** the absolute latitude is stored and at step **1104** the absolute longitude is stored.

The processor enters a loop including wait state **1106** until it is time, usually after a period of 10 minutes for the next data entry to be recorded. Thus, after this period of time, the question asked at step **1105**, as to whether it is time to record data, will be answered in the affirmative, resulting in control being directed to step **1107**.

At step **1107** a question is asked as to whether the ignition is on and if answered in the affirmative relative data is recorded at step **1108**. Thereafter, control is returned to step **1105**. Eventually, the ignition will be switched off, resulting in the question asked at step **1107** being answered in the negative. On detecting this condition, control is directed to step **1109**, resulting in the stop time being recorded, whereafter control is returned to step **603**.

The structure of an AEM+4 packet, of the type detected at step **808**, is

detailed in *Figure 12.* A packet **1201** contains a total of twenty-two bytes, with each byte conveying information of a particular type dependent upon its position within the overall packet. A first byte identifies the overall packet type. In this example, the type may identify the packet as an instruction or as an acknowledgement.

The second byte identifies a unique reference number and this allows duplicates to be identified and discarded. The third packet identifies the calling phone number length followed by a fourth packet identifying an international calling code. This is followed by bytes five to ten which have been allocated for the provision of a phone number although for a particular phone number not all of these bytes may be required and the total length of the number is identified by the phone number length byte, byte three. Byte eleven provides information relating to a protocol identifier followed by a byte (twelve) to identify the format of the user data, such as eight-bit format or seven-bit format for example.

Byte thirteen identifies a validity period, typically of twenty minutes. This is the period over which the SMS system will continue to transmit the SMS message and will then give up after this period if transmission has not been successful. The GSM system attempts to establish a telephone call and the system is made aware of the fact that a receiving telephone is either active, in use or not available. Thus, if it is not possible to make the transmission due, for example, because the receiving equipment is switched off, the GSM system will wait until a flag has been set identifying a condition to the effect that the equipment is available to receive the information. If this flag setting operation does not occur within the validity period, the system will cease attempting to make the communication.

The fourteenth byte identifies the length of the following user-data which, in this embodiment, is set to a byte length of eight bytes. Bytes fifteen, sixteen, seventeen and eighteen transmit the characters AEM4, with the AEM characters being represented in ASCII and the digit four being

represented as binary 4. This is then followed by four bytes of the actual download instructions.

The four byte download instructions have been expanded to bit level in *Figure 12*, thereby providing a total of thirty-two bits for conveying the download instructions. The first sixteen bits represent a transmission day, with seven bits being allocated to represent the year, four bits being allocated to represent the month and the remaining five bits being allocated to represent the day. This is then followed by five bits representing the hour, with the next two bits representing quarters of the hour. The twenty-fourth bit is a flag which is set to indicate that the data is to be transmitted in the future in accordance with the instruction and in accordance with the present invention. The twenty-fifth bit is set if a download of information is required now, ie as an immediate response to the SMS message being received. The remaining seven bits are used to represent repeat days. Thus, these bits are effectively used as flags indicating that a repeat is to occur on Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and/or Sunday.

The nature of the packet allows different download operations to be instructed. If the "now" flag is set, the download occurs immediately, subject to local conditions permitting. If the "then" flag is set, instructions are interpreted for a download to occur in the future. It is possible for both the "now" flag and the "then" flag to be set, such that a download occurs immediately and a subsequent download instruction is recorded.

If the year, month and day information relate to a day in the future, a download instruction is recorded to the effect that an instruction must take place on that day. This may then be followed by repeat day information at the specified hour. Alternatively, the year, month and day information may relate to a day that has passed, in which case this information is ignored and repeat instruction data is considered at the specified hour and quarter hour.

Coding for the quarter hour periods is illustrated in *Figure 13*. The value of 00 results in the download occurring exactly on the hour, with a

value of 01 representing fifteen minutes past the hour, a value of 10 representing thirty minutes past the hour and a value of 11 representing forty-five minutes past the hour.

A single repeat day may be specified in the repeat data or alternatively multiple repeat days may be specified, as illustrated in *Figure 14*. It can be seen from Figure 14 that a repeat day sequence of 0000010 represents a download to occur every Saturday. Similarly, 0101000 represents download every Tuesday and Thursday, with 1111100 representing download Monday to Friday and a full run of 1's representing download every day.

A confirmation type packet, the type transmitted at step **806**, is detailed in *Figure 15*. The packet identifies packet type followed by a phone number length, international code and vehicle phone number. This is then followed by a byte representing the protocol identifier and user data format. Bytes are then allocated representing the time and date on which the message was sent, followed by a byte representing the length of user data. The user data includes a total of 15 bytes, representing the date, time at which the vehicle started and stopped, the vehicle longitude, the vehicle latitude, speed, mileage and a representation of the download flag.

It can be appreciated that the invention provides for the advantage of base station driven polling to be combined with the advantage of vehicle initiated transmission. The base station has a schedule defining when data transfers are to take place. Instructions are then transmitted over SMS to each individual operational station providing instructions as to when, in the future, a data transmission is to be initiated. The initiation of the data transfer is then under the control of the operational stations themselves, allowing the data transfer to take place only if local conditions permit.

Claims

1. A method of transferring operational data collected at a plurality of remote operating stations to a data base station, wherein

each operational station collects data over an operational period;

said base station is configured to instruct remote said stations as to when to initiate a data transfer in response to a predefined schedule; and

each operational station is configured to process instructions received from said base station, to identify a time for initiating a data transfer, and to initiate a transfer of collected data to said base station at said instructed time.

2. A method according to claim **1**, wherein said operational stations are attached to motor vehicles and data collected over said operational period relates to the operation of the vehicle to which the operational station is attached.

3. A method according to claim **1**, wherein said collected data relates to geographical positions of the vehicle to which the operational station is attached.

4. A method according to claim **2** or claim **3**, wherein said data relates to operational conditions of the said vehicle.

5. A method according to any of claims **1** to **4**, wherein an instruction signal identifies a specific time for a data transfer to be initiated.

6. A method according to claim **5**, wherein said instruction instructs a remote operational station to transfer data at a particular time, at a particular day of the week and to continue transmitting at the appointed time and day until further instructions are received.

7. A method according to any of claims **1** to **6**, wherein said base station contacts remote stations by means of GSM SMS messages.

8. A method according to any of claims **1** to **7**, wherein remote stations download data by means of a GSM data channel.

9. A method according to claim **1**, wherein, at the instructed time, a check is made to determine whether appropriate conditions exist for the data transfer to take place.

10. A method according to claim **10**, wherein said checking operation involves checking that the ignition of a vehicle is switched off.

11. Apparatus for transmitting operational data collected at a plurality of remote operating stations to a data receiving base station, comprising

means for collecting data at each operational station over an operational period;

means at said base station configured to instruct said remote stations as to when to initiate a data transfer in response to a predefined schedule; and

means at said operational stations configured to process instructions received from said base station, to identify a time for initiating a data transfer, and to initiate a transfer of collected data to said base station at said instructed time.

12. Apparatus according to claim **11**, wherein said base station includes means for contacting remote stations by means of GSM SMS messages.

13. Apparatus according to claim **11** or claim **12**, wherein said remote stations include means for downloading data over a GSM data channel.

14. Apparatus according to any of claims **11** to **13**, wherein said remote stations include means for checking to determine whether an appropriate condition exists for a data transfer to take place.

15. Apparatus according to claim **14**, wherein said means for checking an appropriate condition is configured to check that the ignition of a vehicle has been switched off.

16. Apparatus attachable to a motor vehicle and configured to collect operational data relating to operational characteristics of said vehicle, comprising

means for receiving instructional data from a base station identifying a time at which a data transfer is to be initiated; and

means for initiating a transfer of collected data to an instructing base station at said instructed time.

17. Apparatus according to claim **16**, configured to collect operational data relating to positions of a vehicle over an operational period.

18. Apparatus according to claim **17**, including means for receiving GPS satellite signals and means for processing signals received from said satellites in order to determine vehicle positions.

19. Apparatus according to any of claims **16** to **18**, including means for receiving download instructions via a GSM SMS channel.

20. Apparatus according to any of claims **16** to **19** including means for downloading accumulated positional data over a GSM data channel.

21. Apparatus according to any of claims **16** to **20**, including means configured to check that the ignition of the vehicle is switched off at the time instructed to initiate a data download and means for preventing said download occurring if the vehicle ignition is switched on.

22. A method of transferring operational data collected at a plurality of remote operating stations substantially as herein described with reference to the accompanying drawings.

23. Apparatus for transmitting operational data collected at a plurality of remote operating stations to a data receiving base station substantially as herein described with reference to the accompanying drawings.

24. Apparatus attachable to a motor vehicle and configured to collect operational data relating to operational characteristics of the vehicle substantially as herein described with reference to the accompanying drawings.

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Application No:	GB 9825888.2	**Examiner:**	Catherine Schofield
Claims searched:	1-24	**Date of search:**	23 March 1999

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4L (LDA, LDGX, LDRRS, LDRRX, LDLX), G4Q (QAJ, QAF), H4D (DPBC, DAB)

Int Cl (Ed.6): G07C: 5/00, 5/08; G08G: 1/127; H04Q: 7/20, 7/22; G01S: 5/00, 5/14

Other: Online:- WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2318940 A	(MINORPLANET) - see particularly page 8, line 28 - page 9, line 25	1, 2, 4, 5, 8, 9, 10, 11, 13 - 16, 18, 20
Y	GB 2317791 A	(MINORPLANET) - see particularly page 3, lines 13 - 29	9, 10, 14, 15, 18
Y	GB 2303023 A	(KNIGHTSBURY HOLDINGS) - see particularly abstract	1, 2, 4, 5, 8, 11, 13, 16, 20
Y	GB 2236642 A	(NATIONAL GRID) - see particularly page 7, lines 7 - 36	1, 2, 4, 5, 11, 16
X	WO 95/17686 A1	(INDUSTRIAL RESEARCH) - see particularly page 6, lines 4 - 12	1, 2, 3, 11, 16, 17, 18
Y	WO 90/09645 A1	(WARNERDALE) - see particularly page 4, lines 4 - 7	1, 2, 4, 5, 8, 11, 13, 16, 20

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Application No: GB 9825888.2 **Examiner:** Catherine Schofield
Claims searched: 1-24 **Date of search:** 23 March 1999

Category	Identity of document and relevant passage		Relevant to claims
X,Y	US 5652707	(WORTHAM) - see particularly column 5, line 44 to column 6, line 34	X:1, 2, 3, 4, 9, 11, 14, 16, 17 Y: 9, 10, 14, 15, 18

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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